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Towards global fully-distributed regionalization of hydrological model parameters

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All hydrological models need to be calibrated to obtain satisfactory streamflow simulations. Here we present a novel parameter regionalization approach that involves the optimization of transfer equations linking model parameters to climate and landscape characteristics. The optimization was performed in a fully spatially distributed fashion at high resolution (0.05°), instead of at lumped catchment scale, using an unprecedented database of daily observed streamflow from 4229 headwater catchments (<5000 km^2) worldwide. The optimized equations were subsequently applied globally to produce parameter maps for the entire land surface including ungauged regions. The approach was implemented using a bounded version of the Kling-Gupta Efficiency metric (KGE_B) and a gridded version of the HBV hydrological model. Ten-fold cross-validation was used to evaluate the generalizability of the approach and to obtain an ensemble of parameter maps. For the 4229 independent validation catchments, the regionalized parameters yielded a median daily KGE_B of 0.30 (equivalent to a conventional KGE of 0.46). The median KGE_B improvement (relative to uncalibrated parameters) was 0.21, with improvements obtained for 88 % of the independent validation catchments. These scores compare favourably to those from previous large catchment sample studies. The degree of performance improvement due to the regionalized parameters did not depend on climate or topography. Substantial improvements were obtained even for independent validation catchments located far from the catchments used for optimization, underscoring the value of the derived parameters for poorly gauged regions. The regionalized parameters — available via www.gloh2o.org/hbv — should be useful for numerous hydrological applications requiring accurate streamflow simulations.